Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's Rules to	)	WT Docket No. 04-435
Facilitate the Use of Cellular Telephones and	)	
Other Wireless Devices Aboard Airborne Aircraft	)	

REPLY COMMENTS OF THE BOEING COMPANY

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SUMMARY

The Boeing Company ("Boeing") believes that the Commission can adopt a regulatory regime for airborne wireless services that balances the interests of consumers, aeronautical communications service providers and CMRS licensees, and facilitates the introduction of new and innovative communications services for the benefit of passengers and crew onboard aircraft in flight. The record developed in this proceeding evidences broad support for airborne wireless services. The commenters recognize the numerous benefits consumers will derive through greater access to wireless services onboard aircraft in flight, including the ability to communicate with friends and family to coordinate schedules and provide other important information, to revise travel arrangements in the event of diverted or delayed flights, and to connect to the office to complete work or conduct business with colleagues.

Given the substantial public interest benefits, the concerns of certain commenters regarding cell phone etiquette should not deter the Commission from permitting in-flight wireless communications. Many passengers are likely to use their wireless devices for unobtrusive data applications such as email, Internet browsing, and instant messaging. Even with respect to voice calling, however, it is unnecessary for the Commission to deny subscribers the opportunity to stay connected onboard aircraft because each airline can, and will, establish its own policies to protect the interests of its passengers and crews. The Commission consistently has allowed the marketplace to determine issues involving wireless etiquette, and there is no reason to take a different approach for airborne wireless services.

In considering the technical and operational rules for airborne wireless services, the Commission should keep in mind the international nature of the air transportation industry. It is essential that the Commission adopt rules that permit operation of airborne picocell systems onboard U.S.-registered aircraft operating outside the country, and onboard foreign-registered aircraft while in U.S. airspace subject to compliance with applicable rules. The Commission

should also consider international developments in adopting an appropriate regulatory and technical regime for airborne wireless operations in the United States.

Boeing has continued to refine its analyses of various technical issues associated with airborne wireless operations and, as discussed in its initial comments, believes that properly designed picocell systems will have only a *de minimis* interference impact on terrestrial wireless operations. In this connection, the use of picocells equipped with network control units ("NCUs"), which generate a low-level "white noise" that prevents onboard wireless devices from communicating with terrestrial wireless networks, may be an effective means of managing wireless communications onboard aircraft in flight. The use of NCUs is one element of the technical implementation for airborne wireless services being pursued in Europe, and could be operated in the United States on a non-harmful interference basis and consistent with the provisions of the Communications Act. Boeing is currently conducting a flight test program to examine potential interference concerns associated with onboard picocell system operations.

Finally, Boeing agrees with the general objectives set forth in the comments filed by U.S. agencies responsible for homeland security, and recognizes that an aircraft cabin is a unique environment that may present challenges to law enforcement. Nevertheless, it is unnecessary for the Commission to adopt rules of general applicability to address the concerns raised by the agencies. The requirements of the Communications Assistance for Law Enforcement Act ("CALEA") already apply to telecommunications carriers whose subscribers will be using their handsets to originate and terminate calls onboard aircraft over their home carrier or roaming partner network, and any additional capabilities associated with the provision of airborne wireless services can be addressed through system-specific agreements with a limited number of air-to-ground service providers.

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REPLY COMMENTS OF THE BOEING COMPANY

The Boeing Company ("Boeing") hereby submits its reply comments in the above-captioned proceeding regarding the use of cell phones and other wireless devices onboard aircraft to provide further information regarding the technical issues associated with onboard picocell system operations, update the Commission on the status of Boeing's flight test program, and address the international aspects of airborne wireless service and other matters raised by interested parties in this proceeding.[1/]

I. INTRODUCTION

In its initial comments, Boeing presented its preliminary views on a regulatory and technical approach for airborne wireless services that would permit the introduction of these new and important services without undermining other uses of the spectrum. Specifically, Boeing suggested that the use of onboard picocell systems will effectively control the power levels of wireless devices to prevent harmful interference to other authorized users of the band, and that the Commission may limit the maximum radiated emissions level for individual airborne picocell systems such that the aggregate level of interference from all airborne picocell systems into the

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1/ *Amendment of the Commission's Rules to Facilitate the Use of Cellular Telephones and Other Wireless Devices Aboard Airborne Aircraft*, 20 FCC Rcd 3753 (2005) ("*NPRM*").

terrestrial wireless network would not exceed a specified level.[2/] Boeing also provided a detailed Technical Appendix with its comments that described a methodology for deriving a maximum emission level for individual picocells systems onboard aircraft.

Boeing's ongoing analyses suggests that airborne wireless services can be provided using onboard picocell systems in a manner that will not cause harmful interference to terrestrial wireless networks. Notably, detailed computer simulations demonstrate that properly designed picocell systems will have only a *de minimis* interference impact on terrestrial wireless operations (*i.e.*, average interference will be less than 1 dB for 99.9 percent of the time). To supplement its technical analyses, Boeing is conducting flight tests to examine operational issues associated with onboard picocell systems under real world conditions.

Foreign regulators and wireless service providers also are developing approaches to facilitate the introduction of airborne wireless services abroad. Given the international nature of the aviation industry and the particularly pressing need for communications services onboard long-haul international flights, Boeing believes that the Commission should consider international developments regarding airborne wireless services and take international issues into account in developing an appropriate U.S. regulatory regime for such services.

II. AUTHORIZING AIRBORNE WIRELESS SERVICES WOULD SERVE THE PUBLIC INTEREST

As a leading provider of broadband communications services to aircraft through its Connexion by Boeing[sm] Ku-band Aeronautical Mobile-Satellite Service ("AMSS") offering, Boeing strongly supports the Commission's efforts to facilitate the introduction of airborne

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2/ Boeing suggested that the Commission could consider harmful interference to be an increase in the noise floor of terrestrial wireless networks in excess of 1 dB based on relevant precedent. *See* Boeing Comments at 13-15.

wireless services. The comments submitted in this proceeding reveal widespread support for such services in the United States.

A. There Is Broad Support for Airborne Wireless Services

Although some parties raise various technical and operational concerns (including "social" or "etiquette" issues), commenters representing all segments of the communications and airline industries, as well as several U.S. government agencies, concur with the Commission's assessment that allowing the use of wireless devices on airplanes "will benefit consumers by adding to future and existing air-ground communications options that will provide greater access for mobile voice and broadband services during flight."[3/] Further, as Boeing pointed out, not only will the Commission's action provide significant advantages to travelers, but airlines will gain "another important amenity -- the ability for passengers to access wireless services -- to attract customers."[4/]

Other telecommunications providers likewise assert that "[t]he provision of wireless services onboard aircraft in flight is a natural extension of the services already provided by today's CMRS licensees,"[5/] and that "[a]llowing the use of handsets and other wireless devices during flight would boost the productivity of business travelers and enhance personal communications for many millions of airline passengers."[6/] Manufacturers of wireless devices

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3/ *NPRM* ¶ 2.

4/ Boeing Comments at 2.

5/ Cingular Wireless/Verizon Wireless Joint Comments at 1-2.

6/ AirCell Comments at 3; *see also* Sprint Comments at 1 ("Sprint believes that the use of cell phones in airplanes that are in flight may well present a valuable new facet to existing CMRS services that has been largely untapped for various technical and regulatory reasons, and Sprint has begun examining the feasibility of providing this capability to more than 25 million subscribers who use its network today."); Telenor Satellite Services and ARINC Comments at 1 ("we wholeheartedly agree with the Commission's assessment that an action to lift the ban will ultimately benefit consumers and public-safety personnel").

and equipment agree that the public interest favors the introduction of airborne cellular service. Motorola, for instance, states that "[d]eployment of wireless systems on commercial aircraft could greatly benefit the general public by extending service during periods of travel, and holds the potential for increasing the utility of wireless services to the consumer."[7/] The Consumer Electronics Association ("CEA") offers the results of its research, which found that "more than one-third of all travelers and 60 percent of business travelers believe that it would be beneficial to have access to a wireless network or the Internet while in flight."[8/]

Representatives of the airline industry also appreciate the increasing consumer demand for in-flight connectivity. United Airlines "supports efforts to explore innovative technology in demand by its customers," and "is firmly committed to pursuing onboard technology products that are valued by its customers and meet its stringent airline safety standards."[9/] The International Brotherhood of Teamsters ("IBT"), Airline Division, states that, subject to certain conditions, it would support lifting the ban on the use of such devices.[10/] Rockwell Collins, a manufacturer of avionics equipment, likewise, "commends the Commission for undertaking the complex task of bringing the FCC's regulation in-line with today's technological advances," and is "pleased the FCC is reexamining its regulation concerning the use of cellular phones aboard airborne aircraft."[11/]

7/ Motorola Comments at 2.

8/ CEA Comments at 3; *see also* Ericcson Comments at 1 ("By eliminating unnecessary regulatory restrictions, the FCC will provide carriers greater flexibility to deploy services in response to evolving market demands."); Honeywell Comments at 3.

9/ United Airlines Comments at 2.

10/ IBT Airline Division Comments at 2.

11/ Rockwell Collins Comments at 1-2.

In addition, the Department of Justice, Federal Bureau of Investigation, and Department of Homeland Security (collectively "the Departments") "support the Commission's efforts to (1) make additional communications options available to Americans and (2) protect and promote public safety and homeland security by increasing airborne communications options available for public safety and homeland security personnel, including a greater ability to engage in direct air-to-ground communications in an emergency."[12/] VeriSign, which provides lawful interception capability and subpoena processing services to communications providers, agrees that the Commission's action "promises to make available a cornucopia of wireless Next Generation Network (NGN) services on board aircraft worldwide," for the benefit of consumers.[13/]

The broad interest in facilitating in-flight use of wireless devices is not limited to the United States. The Societe Internationale de Telecommunications Aeronautiques ("SITA"), an airline industry-owned, European provider of global information technology and telecommunications solutions to the air transport and related industries, says that it has expended significant resources to develop an airborne cellular system, not out of "idle curiosity or a desire to experiment with new technologies."[14/] Rather, "SITA's internal market studies have shown a significant demand for in-flight connectivity that is not being met at present."[15/] As SITA explains, the two-way capability of picocell service will give subscribers peace of mind, knowing they can be reached instantly by family and business colleagues when emergencies or other important matters arise, as well as allowing travelers to alert others of changes in plans or

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12/ Departments Comments at 2.

13/ VeriSign Comments at 3.

14/ SITA Comments at 20.

15/ *Id*. Based on its studies, SITA estimates that "the addressable market for onboard service via picocells on both long and short haul flights will be over 700 million passengers by 2009 and that the value for onboard communications will be $1.6 billion for voice and $400 million for data." *Id.* at 21-22.

schedules such as delayed arrivals or diverted flights.[16/] Further, SITA notes that business productivity would be enhanced through the ability to maintain contact during the flight, and that "[w]ireless subscribers have grown accustomed to the many positive rewards of seamless connectivity, and the proposed use of handsets onboard airplanes extends those benefits to airborne travelers."[17/]

B. The Commission Should Not Base its Determination on Operational or Etiquette Concerns

The concerns of certain commenters regarding operational "policing" or cell phone etiquette should not deter the Commission from permitting in-flight wireless communications, given the associated public interest benefits. With respect to the use of wireless devices for data transmission, such concerns are irrelevant. Cellular capability is increasingly being incorporated into laptop computers and PDAs (replacing or complementing IEEE 802.11 technology), and many wireless handsets allow subscribers to surf the Web, download data, and send and receive email and instant messages. Declining to permit airborne cellular service based on concerns about potentially loud or inconsiderate voice calling[18/] would eliminate the opportunity for passengers to use their cellular devices in a completely unobtrusive manner -- *e.g.*, text messaging or emailing family members with flight arrival information, connecting to office servers to complete work and communicate with colleagues, conducting last-minute research for a presentation at the destination location, and "chatting" online with friends.

Even with respect to voice calling, it is unnecessary for the Commission to deny airline passengers opportunities to stay connected onboard because each airline will have the ability to

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16/ *Id.* at 22.

17/ *Id*.

18/ *See, e.g.*, Association of Flight Attendants-CWA, AFL-CIO Comments at 7-9.

establish its own policies regarding the use of wireless devices. Airlines control all services within their cabins and should have the opportunity to choose both the picocell service provider and the range of telecommunications services offered. As CEA explains, although it supports limits on voice services, it recognizes that such limits are appropriately "determined and enforced by individual airlines."[19/] If voice calling leads to the situations anticipated by some commenters, then airlines may prohibit anything other than data use of cellular devices, or restrict the locations within the aircraft or times at which voice calling is permitted. Passengers are perfectly capable of following cabin crew directions -- they turn off electronic devices, stow tray tables, and put seats in their upright position before takeoff and landing. There is no reason to believe that they will fail to follow instructions regarding permissible use of cell phones.[20/]

Ultimately, airborne cell phone etiquette questions should be decided by the marketplace rather than through FCC regulation.[21/] Airlines can and will set policies to protect the interests of their passengers and crews, and if the flying public demands more stringent controls on voice calling or other wireless device uses, they will get them. As AirCell notes, objections about airborne cellular use "are similar to the resistance raised with the first wave of wireless phone growth. As it turns out, the American people have determined how to use their phones in a

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19/ CEA Comments at 7. In 2003, CEA developed etiquette guidelines for public use of wireless phones, and asserts that it "stands ready to work with the technology community, airline industry consumer associations, and other interested parties to address the social issues related to the in-flight use of portable electronic devices for voice communications." *Id.* at 7-8.

20/ Nor is there any basis for Morality in Media's fear that use of cell phone technology will expose unwitting passengers to indecent pictures, movies, or conversations. *See* Morality in Media's Comments at 3-7. Today, airline travelers are permitted to view movies from their own libraries on personal portable DVD players and laptops and can scroll through photos they have downloaded previously. They also can bring books and magazines of their choice onboard. The airlines all have policies on the appropriate use of these new and old "technologies," and have the authority under FAA regulations to prevent passengers from inflicting their viewing choices on others. It is wholly unnecessary for the Commission to establish special rules governing cellular telephone "indecency" or to ban the use of cellular devices altogether on this basis.

21/ *See, e.g.*, SITA Comments at 23.

generally acceptable manner."[22/] In more than two decades of addressing hundreds of wireless issues, including licensing, spectrum allocation, consumer protection, and safety and emergency services, the Commission has never become involved in the debate over wireless etiquette. Questions about manners for airborne cellular use, likewise, should not factor into the Commission's consideration of the proposals set forth in the *NPRM*.

III. THE COMMISSION SHOULD TAKE INTO ACCOUNT INTERNATIONAL ISSUES ASSOCIATED WITH THE PROVISION OF AIRBORNE WIRELESS SERVICES

Given the international nature of the air transportation industry, Boeing believes that the unique technical and regulatory issues raised by airborne wireless services will need to be addressed on a harmonized basis. Accordingly, in adopting rules and policies governing airborne wireless services, the Commission should specifically address international operations over which it has regulatory authority (*e.g.*, the provision of service onboard U.S.-registered aircraft outside the United States and onboard foreign-registered aircraft in U.S. airspace) and should take into account international developments regarding airborne wireless services.

A. The Commission Should Authorize International Airborne Wireless Services

As discussed in Boeing's initial comments, the Commission should adopt rules that permit operation of airborne picocell systems on U.S.-registered aircraft operating outside the United States.[23/] The Commission retains full and exclusive jurisdiction over a U.S. aircraft equipped with an airborne picocell system that is located in international airspace.[24/] Authorizing airborne picocell system operations aboard U.S.-registered aircraft located outside the United

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22/ AirCell Comments at 9.

23/ Boeing Comments at 22-24.

24/ 47 U.S.C. § 301(e); *see also* ITU-R Radio Regulations, Chapter VIII (Aeronautical Services) (acknowledging, among other things, that aeronautical stations (including aircraft earth stations) are subject to the authority of responsible administrations along international routes).

States would be consistent with general principles of international law.[25/] There is an even greater potential demand for communications options onboard long-haul international flights than on domestic routes, and the important public benefits discussed above with respect to airborne wireless services in the United States are at least as applicable to international flights.[26/] Because potential interference into terrestrial wireless networks is not an issue for airborne picocell systems operating in international airspace (*i.e.*, over international waters), the Commission may move forward expeditiously to permit such operations onboard U.S.-registered aircraft (subject to FAA requirements).[27/] Airborne picocell system operations onboard U.S.-registered aircraft also should be permitted within the territory of foreign nations subject to compliance with the requirements of those nations.[28/]

Similarly, allowing airborne picocell systems on foreign-registered aircraft to operate within the United States would be in the public interest. Assuming full compliance with

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25/ In this connection, the Convention on International Civil Aviation (to which the United States is a Signatory) explicitly recognizes that "appropriate authorities" of the nation in which an aircraft is registered retain licensing authority over radio stations aboard that aircraft even when located above the territory of a foreign nation, provided such aircraft's radio stations are operated in accordance with the regulations of that foreign nation. *See* Convention on International Civil Aviation at Art. 30 (signed Dec. 7, 1944) ("*Chicago Convention*"); *see also* Resolution A29-19 of the ICAO General Assembly (Montreal, October 1990), *available at* http://www.icao.int/icao/en/res/a29_19.htm.

26/ *See supra* Section II.

27/ The Commission may permit airborne picocell system operations onboard U.S.-registered aircraft operating outside the United States (subject to FAA requirements) even if additional time is needed to address regulatory and technical issues associated with the provision of airborne wireless services in the United States.

28/ The Commission recently adopted rules permitting the operation of earth stations onboard vessels ("ESVs") on U.S.-flagged vessels in and near the territory of foreign nations subject to compliance with the regulatory requirements of those nations. *See Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands*, 20 FCC Rcd 674, ¶¶ 47-52 (2005). A similar approach has been proposed for the operation of aircraft earth stations ("AESs") onboard U.S.-registered aircraft operating in Ku-band AMSS spectrum. *See Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, 20 FCC Rcd 2906, ¶¶ 57-59 (2005).

applicable rules,[29/] including operation in U.S. CMRS spectrum bands and adherence to technical requirements designed to prevent harmful interference into terrestrial wireless networks, there is no basis for prohibiting airborne picocell system operations on foreign-registered aircraft. As SITA suggests, the Commission should recognize authorizations issued by a foreign aircraft's country of registry under Article 30 of the Chicago Convention, subject to compliance with U.S. operational and technical requirements.[30/] Boeing believes that the non-interfering nature of compliant airborne picocell system operations would permit Commission recognition of foreign-country authorizations, and that mutual recognition of picocell system authorizations would facilitate the provision of airborne wireless services onboard U.S.-registered aircraft traveling within the territory of foreign countries.

B. Foreign Regulators Are Actively Working To Facilitate the Introduction of Airborne Wireless Services

As the Commission is aware, this proceeding is not occurring in a vacuum. In Europe and Asia, regulators and carriers also are in the process of developing their own frameworks for airborne wireless services and are considering many of the same items at issue here. For example, the Electronic Communications Committee ("ECC") of the European Conference of Postal and Telecommunications Administrations ("CEPT"), has been considering for a number of years how best to facilitate the free circulation and use of Airborne GSM Base Transceiver Stations (GSM-specific picocells). In addition, the Wireless Working Group of the Asia Pacific

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29/ An airborne picocell system authorized by another administration onboard a non-U.S. aircraft would be subject to the Commission's jurisdiction whenever it flies in U.S. airspace. *See* 47 U.S.C. § 301(f). Section 87.191(a) of the Commission's rules also provides that "[a]ircraft of member States of the International Civil Aviation Organization may carry and operate radio transmitters in the United States airspace only if a license has been issued by the State in which the aircraft is registered," but that "[t]he use of radio transmitters in the United States airspace must comply with [the Commission's] rules and regulations." 47 C.F.R. § 87.191(a).

30/ SITA Comments at 34-37.

Telecommunity ("APT") is commencing its consideration of this matter, with a view to harmonizing treatment of Airborne GSM Base Transceiver Stations in the Asia Pacific region with that in Europe.

In Europe, regulators have been actively working to facilitate the introduction of wireless communications for airline passengers and CEPT's Spectrum Engineering Working Group currently is preparing a compatibility study. The ECC likely will seek comment on a draft decision before the end of this year, and CEPT could then put the framework in place by early 2006.[31/] The ECC's Project Team RA6 has recognized the need to ensure the provision of a seamless service while aircraft cross borders of various countries and to avoid burdening regulators, network operators, and airlines with unnecessary regulatory or operational requirements. Accordingly, the ECC's draft decision provides, among other things, that: (i) the system be operated so that it does not claim protection from nor cause harmful interference to any other system; (ii) the decision applies only if the system and its associated components have the appropriate airworthiness certification from the relevant aviation authority; (iii) the spectrum power levels and frequency bands be controlled to ensure that there is no harmful interference with aircraft systems or any other systems operating outside the aircraft; and (iv) administrations allow free circulation and use of such systems provided that the system operator is either authorized to use the required spectrum or has been exempted from the need to be so, in each case by the country of registration of the aircraft.[32/]

[31/] Andrew Charlton, "OnAir White Paper: The Regulation and Certification of Airline Passenger Communications Systems," July 13, 2005, *available at* http://www.newswireless.net/index.cfm/article/2324.

[32/] CEPT/ECC, Project Team RA6, Draft Decision on the free circulation and use of Airborne GSM Base Transceiver Stations in the frequency bands 1710-1785 and 1805-1880 MHz (Helsinki, 18-19 July 2005), *available at* http://www.ero.dk/ecc; *see also* Andrew Charlton, "Regulation and Certification Of

The Commission should remain cognizant of international developments with respect to airborne wireless services to ensure that the U.S. regulatory regime accommodates foreign regulatory constructs, and to influence international regulatory requirements and technical standards for this important service. If the Commission wishes to maintain U.S. leadership in such advanced communications services, it should move promptly to establish an appropriate regulatory and technical framework for airborne wireless services.

IV. TECHNICAL ISSUES ASSOCIATED WITH THE PROVISION OF AIRBORNE WIRELESS SERVICES

As discussed in Boeing's initial comments in this proceeding, the use of onboard picocell systems to provide airborne wireless services will control the power levels of wireless devices to prevent harmful interference to terrestrial wireless systems. Further analysis suggests that properly designed picocell systems subject to appropriate operational constraints (*e.g.*, no operations below 10,000 feet, prevention of direct off-board communications by wireless devices, etc.) will have only a *de minimis* interference impact on terrestrial wireless operations (*i.e.*, average interference will be less than 1 dB for 99.9 percent of the time).[33/] Boeing is currently conducting a flight test program to examine operational issues associated with onboard picocell systems.

Picocells equipped with network control units ("NCUs") is one element of the technical implementation for airborne wireless services being pursued in Europe, and may be an effective means of managing wireless communications onboard aircraft in flight. NCUs generate a low-level "white noise" that prevents onboard wireless devices from communicating with terrestrial

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Passenger Communications Systems, Head of Regulatory Affairs," OnAir, June 2005, *available at* http://www.onair.aero/en/faq/ on_board_mobile_tel.pdf.

33/ Boeing Comments at 15-16.

wireless networks,[34/] thereby ensuring that the devices operate at low-power with the onboard picocell system only. Such equipment could also be operated in the United States on a non-harmful interference basis and consistent with the provisions of the Communications Act.

A. Further Analysis Demonstrates that Properly Designed Picocell Systems Will Not Cause Harmful Interference to Terrestrial Wireless Networks

To determine whether individual picocell systems would radiate emissions harmful to terrestrial wireless networks, Boeing created a computer model to analyze the aggregate interference into any terrestrial wireless base transceiver station ("BTS") receiver using actual aircraft flight tracks provided by the FAA for a one-week period in May 2005. As part of this analysis, 211 virtual base stations were placed across the continental United States in an evenly spaced grid. Each base station had three sectors covering 120°, with the sectors randomly oriented.[35/] The gain patterns for a commercial high-gain BTS panel antenna were assumed and the antennas were not down tilted -- a worst-case assumption. Aircraft were flown over the base stations and the interference noise into each BTS receiver, in each sector, at each instant of time over a one week period, was logged and later statistically analyzed.

The FAA data contained flight tracks for all types of aircraft including light general aviation aircraft, so the data was filtered to select only aircraft having 100 seats or more, from 28 major airlines, which is the likely market for picocell systems. Of this total potential market, Boeing randomly selected 50 percent of the aircraft to be equipped with picocell systems. The picocell system and the passenger cellular devices communicating with them were assumed to be deactivated below 10,000 feet altitude, in accordance with current FAA regulations governing

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34/ SITA Comments at 11, 16.

35/ The analytical results were not sensitive to the orientation of sectors or the number of sectors, and three-sector base stations were chosen because this is a typical configuration.

the use of personal electronic devices. Boeing also used a simple "smooth Earth" radio propagation model, with $1/r^2$ loss out to the visible horizon of each aircraft, and $1/r^4$ beyond the visible horizon out to the radio horizon.[36/]

Boeing analyzed the worst-case interference scenario of GSM aircraft picocell systems interfering into CDMA base stations on the ground,[37/] and assumed that each picocell-equipped aircraft was servicing seven simultaneous GSM calls from seven GSM handsets operating at their minimum power output of 0 dBm in the PCS band at all times when the aircraft was above 10,000 feet altitude.[38/] To spread the interference power over the PCS band, thereby reducing interference picocell power spectral density ("PSD") on the ground, Boeing assumed that each aircraft picocell system randomly selects an operating frequency within the PCS band. Thus, Boeing divided the PCS band into 725 GSM channels of 200 kHz each and the interference into any CDMA channel on the ground was calculated by summing the PSD from six adjacent GSM channels, which total to 1.2 MHz (or approximately one CDMA channel).

Measurements of aircraft radiated emissions show that deep nulls exist fore and aft of the aircraft fuselage, as well as above and below the fuselage. The window openings in the fuselage cause the radiated emission to be greatest along the plane of the wings and perpendicular to the longitudinal axis of the aircraft. An adequate model for this type of radiation pattern is $\cos^m\psi$,

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36/ The smooth Earth approximation yields more conservative results (increased interference) compared to actual propagation with terrain shadowing.

37/ This is the worst-case interference scenario because GSM handsets are not able to reduce their transmit power below 0 dBM (1 mW), whereas CDMA phones, when under power control by a local picocell, typically reduce their power to less than -20 dBm. Therefore, the picocell to BTS interference scenarios of CDMA to CDMA and CDMA to GSM have been found to cause negligible interference, if all phones are prevented from communicating with terrestrial cellular networks.

38/ It is unlikely that seven simultaneous GSM calls will be conducted at any time during any actual flight, so assuming seven simultaneous GSM calls are being conducted continuously throughout the entire flight is a worst-case assumption.

where ψ is the angle from the axis perpendicular longitudinal axis of the aircraft, as shown in Figure 1.

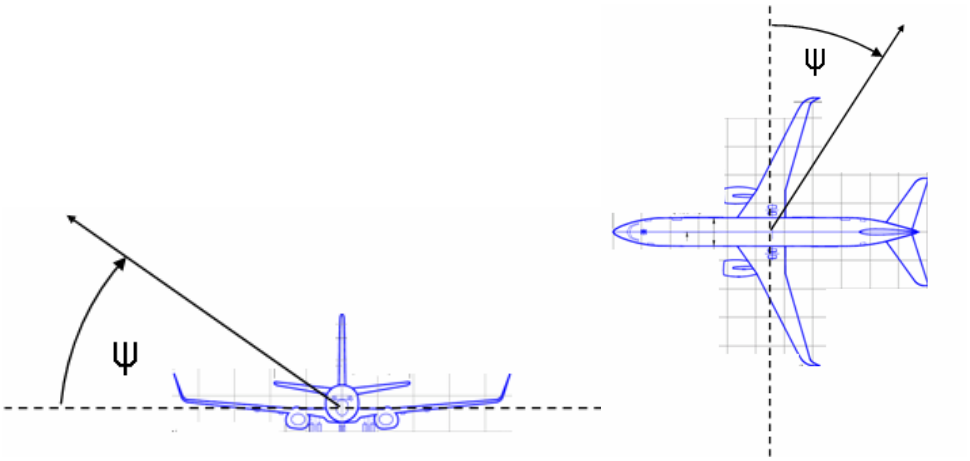

Figure 1 - Definition of ψ

The radiated emissions from the aircraft can be modeled as: $EIRPSD_a(\psi) = P_a\ (1+m)\ \cos^m\psi\ /\ B_{ch}$. The total radiated aircraft picocell system power is: $P_a = A_f\ N\ P_p$ (where, A_f = fuselage attenuation; N = number of active cellular devices; P_p = power controlled transmit power; and m = gain = 1). Boeing assumed that there were seven GSM handsets (N=7) each radiating 0 dBm (P_p =1 mW) into a channel bandwidth of, B_{ch} = 200 kHz.

The interference noise into the BTS receiver from the aircraft picocell system is given by, $PSD_i = EIRPSD_a\ G_r\ L_p$ where the path loss is, $L_p = (\lambda\ /\ 4\ \pi\ R)^2$ within the visual horizon R_v, and $L_p = \lambda^2/\ ((4\pi)^2\ (R_v^2 + (R - R_v)^4)$ beyond the visual horizon.[39/]

Using the foregoing equations, the relative rise in BTS receiver noise is: $\Delta N = (PSD_i(total) + PSD_{thermal})\ /\ PSD_{thermal}$, and express result in dB as, 10 log (ΔN). Thermal noise

[39/] $G_r(\Phi, \theta)$ is found from data provided by the BTS antenna manufacturer. (Φ, θ) are the azimuth and elevation angles to the aircraft from the BTS, as measured from antenna boresight. Boeing assumed a panel antenna from Andrew Corp. (part number DB982G105E-M) having a peak gain of 17.3 dB in the PCS band.

into BTS receiver is: $PSD_{thermal} = k\ T_0\ (NF - 1)$ where $T_0 = 290$ ºK, NF = 2 (3 dB), k = 1.38E-23 J/ºK.

Figure 2 shows the percentage of time (over the one week period of analysis) that the interference (for all base stations) into a single CDMA channel is below some interference level (y-axis) given some amount of fuselage attenuation (x-axis). Assuming a maximum rise in the noise floor of 1 dB, the results show that this can be achieved 99.9 percent of the time with 4 dB of average fuselage attenuation. Given that average fuselage attenuation is assumed to be on the order of 10 dB,[40/] the aggregate interference from picocell-equipped aircraft should be significantly below 1 dB for more than 99.9 percent of the time.

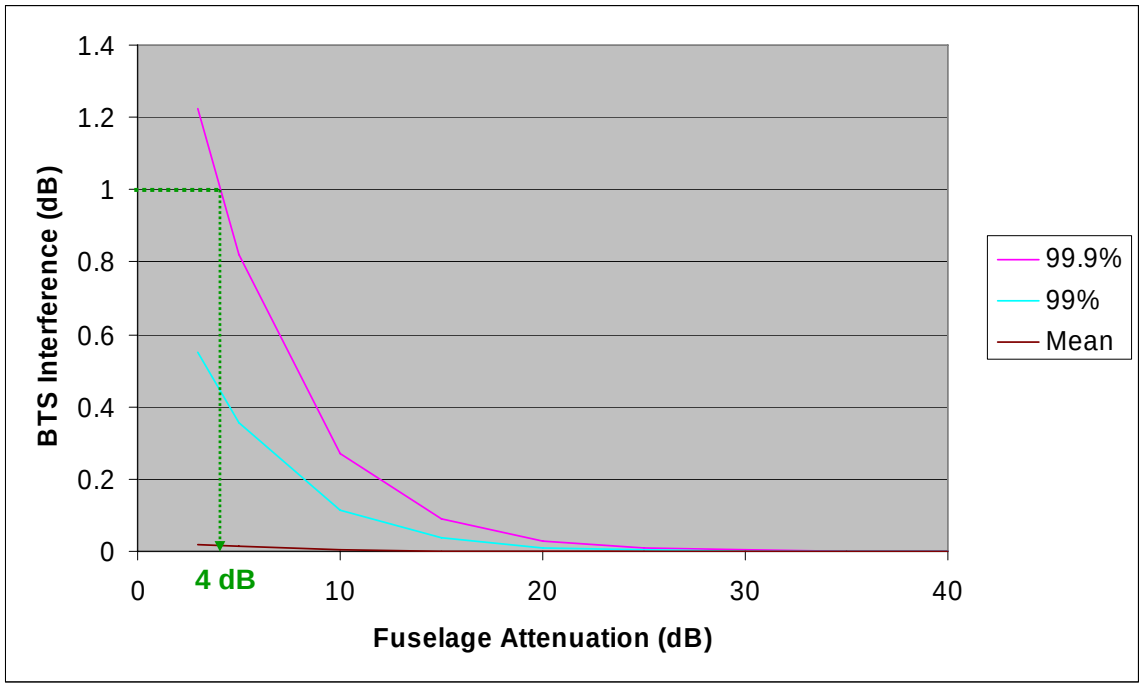

Figure 2 - Picocell System Interference versus Fuselage Attenuation

40/ Wireless Cabin Technical Note, "Power and Interference Consideration for Airborne Mobile Telephone Systems," Information Society Technologies, IST-2001-37466; *see also* SITA Comments at 17.

In an effort to validate the assumptions regarding fuselage attenuation, path loss at altitude and other variables used in its analyses, as well as to examine other operational issues regarding onboard picocells systems, Boeing has recently begun a flight test program that will continue through the month of August 2005. Working in conjunction with Qualcomm, Boeing is utilizing its 737-400 testbed aircraft (Connexion One) to examine operational issues associated with onboard picocell systems. Boeing intends to supplement the record of this proceeding with additional technical information and analysis of the results of its flight test program after such tests are completed.

B. NCUs May Be an Effective Means of Managing Wireless Services Onboard Aircraft in Flight

European airborne wireless service proponents have recommended solutions that employ picocells equipped with NCUs, which radiate low-level "white noise" to prevent terrestrial networks from being visible to the passengers' handsets inside the aircraft.[41/] Because wireless devices will see only the onboard picocell, communications will occur at very low power given their close proximity. The low power levels of the handsets and transceivers will, in turn, protect terrestrial networks from harmful interference.[42/]

Studies performed by Boeing indicate that the receive signal-to-noise ratio ("SNR") of forward link signals from terrestrial wireless networks must be reduced by approximately 40 dB to prevent the most sensitive CDMA handsets from receiving forward link signal from the

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41/ *See* SITA Comments at 11, 15; *see also* OnAir Presentation to RTCA (April 2005); Wireless Cabin Presentation to RTCA (December 2004).

42/ SITA Comments at 15-16. SITA also looked at physical "screening" of signals within the aircraft (*i.e.*, shielding windows and around door seals and joints, in addition to the minimum 10 dB of isolation, on average, afforded by the aircraft fuselage), but has concluded that physical screening alone would be insufficient to prevent handsets from connecting to terrestrial networks. *See id.* at 17.

ground, when the aircraft is at 10,000 feet altitude, and the handset is located near a window.[43/] Assuming this requirement, the potential interference into a wireless handset on the ground from an NCU-equipped onboard picocell system can be calculated using the method shown in Figure 3, below.

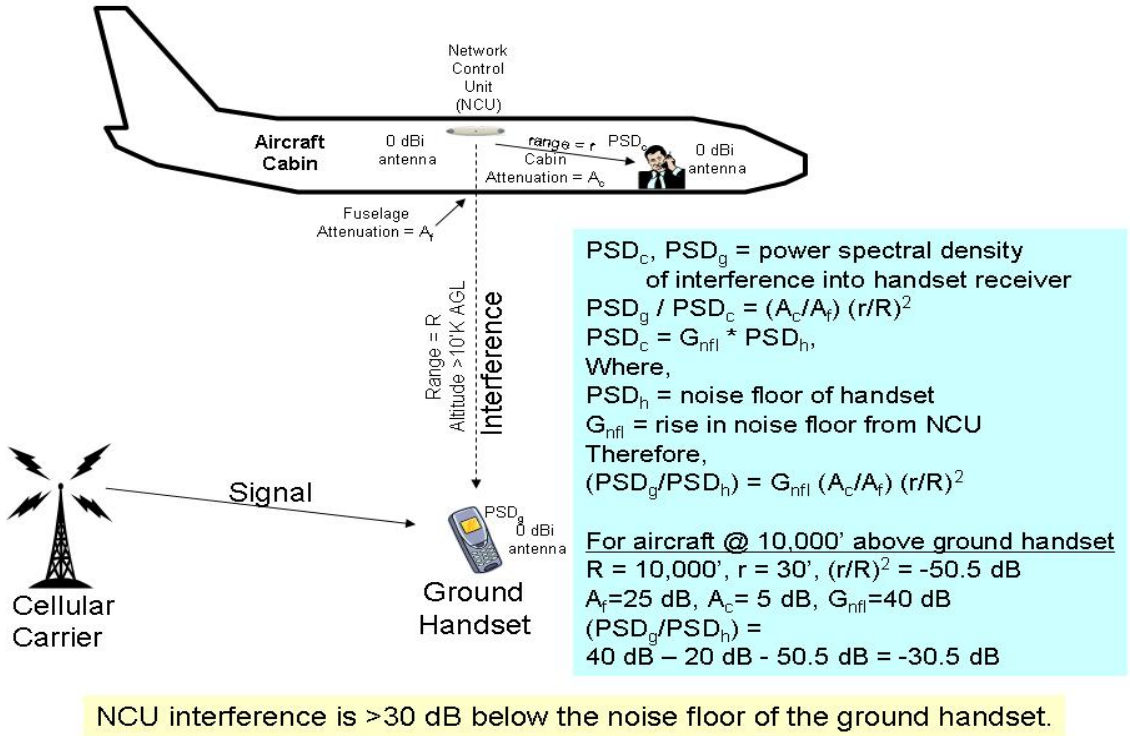

Figure 3 - NCU Interference Analysis (Single Aircraft)

Mandatory shut down of NCU-equipped picocell systems (and passenger wireless devices) at an altitude of 10,000 feet guarantees a minimum path loss isolation of $L_p = (\lambda / 4 \pi R)^2 = -108$ dB in the PCS band. The calculation shown in Figure 3 shows that even at this worst-case altitude, and assuming the NCU antenna and the onboard handset are thirty (30) feet apart (giving differential path loss of 50.5 dB),[44/] the amount of interference into the ground handset

43/ SITA also suggests that 40 dB of attenuation is required to effectively block signals from the terrestrial wireless network. SITA Comments at 17.

44/ A key factor in the analysis is not the path loss to the ground, but rather the ratio of path loss to the ground to the path loss within the cabin, which is inversely proportional to the ratio of distances

may be negligible (30 dB below the noise floor of the ground receiver) when the user is directly below the aircraft because the fuselage attenuation is greatest. At the other extreme, with the aircraft oriented broadside to a ground user at the horizon and the NCU radiation passing through the windows with little attenuation ($A_f < 3$ dB), the long distance between the aircraft and ground handset causes the path loss to dominate and the interference on the ground should remain negligible.

To estimate the potential interference from NCUs operating onboard multiple aircraft, Boeing performed a more complex analysis that accounts for actual aircraft flight tracks, altitudes and flying times. The analysis methods and assumptions are the same as previously described for estimating the interference from onboard cellular devices into terrestrial base stations,[45/] except that the base stations are converted to 0 dBi cellular handsets. The results of this analysis suggest that the aggregate interference from NCU-equipped picocell systems is negligible (less than 0.07 dB for 99.9 percent of the time). The multi-aircraft analysis confirms the single aircraft analysis described in Figure 3 -- that the noise floor rise to a handset on the ground should be negligible for NCUs operating on aircraft above 10,000 feet.

Finally, contrary to arguments made by CTIA and Motorola,[46/] use of NCUs in aircraft to facilitate the provision of airborne wireless service while minimizing the potential for interference to terrestrial wireless providers would not violate the Communications Act or the previous rulings of the Commission. Section 333 of the Communications Act prohibits any

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squared, or $(r/R)^2$. In a report submitted to the RTCA by the Wireless Cabin Consortium in Europe (In-Cabin Channel Measurement and Result Report, Wireless Cabin, IST-2001-37466, 7-31-03) suggests that achieving a cabin loss of A_c=5 dB (in excess of $1/r^2$ propagation loss) between NCU antenna and passenger handset is feasible.

45/ *See supra* Section IV.A.

46/ CTIA at 11-12; Motorola at 7-8.

person from "willfully or maliciously" interfering with or causing interference to any radio communications of any station licensed or authorized by or under the Act or operated by the United States government.[47/] The legislative history of Section 333 identifies willful and malicious interference as "intentional jamming, deliberate transmission on top of the transmissions of authorized users already using specific frequencies in order to obstruct their communications, repeated interruptions, and the use and transmission of whistles, tapes, records, or other types of noisemaking devices to interfere with the communications or radio signals of other stations."[48/]

NCUs operated as part of an airborne picocell system should not be considered a source of willful or malicious interference that would be prohibited by Section 333. The purpose of the NCU is not to "interfere" or "obstruct" airborne communications, but rather to protect terrestrial wireless networks from harmful interference while facilitating the provision of this new service to airline passengers. Indeed, an NCU device would meet the Commission's dual goals of minimizing "the potential for harmful interference to terrestrial systems while providing maximum flexibility to wireless telecommunications carriers seeking to address consumer

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47/ 47 U.S.C. § 333. In addition, under Section 303, the Commission has the authority to suspend the license of any operator upon sufficient proof that the licensee has "willfully or maliciously interfered with any other radio communications or signals." 47 U.S.C. § 303(m)(1)(E). Section 302 similarly prohibits the manufacture, importation, sale or offer for sale of devices designed to block or jam wireless transmissions. 47 U.S.C. § 302(b).

48/ H.R. Rep. No. 101-316, at 13 (1989). The Commission has stated that the "legislative history to [Section 333] makes clear that this section prohibits harmful, intentional interference," *see Application of Capitol Radiotelephone Inc., d.b.a. Capitol Paging, et al*., 8 FCC Rcd 6300, n.13 (1993), and that "the underlying purpose of the statute is to prohibit actions that are expressly designed to cause interference . . . in order to 'obstruct [authorized operators'] communications.'" *Imposition of Forfeiture Against Capitol Radiotelephone Inc. d/b/a Capitol Paging, et al*., 9 FCC Rcd 6370, ¶ 81 (1994).

demand for air-ground connectivity."[49/] NCUs would not create the type of interference the statute was intended to remedy.

V. AIRBORNE WIRELESS SERVICE PROVIDERS CAN FULLY SATISFY LAWFUL INTERCEPTION CONCERNS

The Departments have submitted comments in this proceeding that "support the Commission's efforts to make additional communications options available to Americans, and to protect and promote public safety and homeland security by increasing airborne communications options available for public safety and homeland security personnel…."[50/] The Departments also take the opportunity "to identify for the Commission various national security-related concerns that stem from the proposal" to relax the ban on the airborne use of personal wireless telephones aboard aircraft.[51/]

Boeing agrees with the Departments' general objectives and recognizes that an airplane cabin is a unique environment that may present challenges to law enforcement. It is not necessary, however, to adopt rules of general applicability in this proceeding to address the Departments' concerns. The Communications Assistance for Law Enforcement Act ("CALEA") already applies to those telecommunications carriers whose subscribers will be using an onboard system to originate and terminate calls over the home carrier or roaming partner network.[52/] As the Departments acknowledge, "a call from the passenger's personal wireless telephone would connect to an onboard phone system (such as a picocell) that would then relay the call to the

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49/ *NPRM* ¶ 3.

50/ Departments Comments at ii.

51/ Departments Comments at 2.

52/ 47 U.S.C. § 1001 *et seq.*; *see also Communications Assistance for Law Enforcement Act*, 15 FCC Rcd 7105, 7120 (1999). The Commission has recently determined that CALEA applies to certain facilities-based broadband Internet access providers and interconnected Voice over Internet Protocol service providers. *See* News Release, *FCC Requires Certain Broadband and VoIP Providers to Accommodate Wiretaps* (rel. Aug. 5, 2005).

ground and connect it to the passenger's terrestrial wireless carrier (or a different terrestrial wireless carrier pursuant to a roaming agreement)."[53/] Thus, all such communications of a subscriber under surveillance already must be routed or switched through CALEA-compliant facilities.

Any unique CALEA-related requirements and additional public safety and national security obligations associated with equipment on board aircraft and the link to the ground can be developed through system-by-system arrangements. As Boeing recently noted in its reply comments filed in the AMSS rulemaking docket, the Commission has consistently recognized the unique features of satellite networks used to provide mobile service in the United States and the need for system-by-system arrangements negotiated between law enforcement and satellite carriers to address specific public safety and national security concerns.[54/] A similar approach is warranted here for the limited number of anticipated air-to-ground networks. The combination of such network security agreements for off-board transmissions, coupled with CALEA capabilities resident in terrestrial systems, ensure that law enforcement's needs will be met.

53/ Departments Comments at 5.

54/ *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, IB Docket No. 05-20, Boeing Reply Comments at 17-19 (filed Aug. 3, 2005); *see also* S*pace Station System Licensee, Inc., Assignor and Iridium Constellation LLC, Assignee, for Consent to Assignment of License Pursuant to Section 310(d) of the Communications Act,* 17 FCC Rcd 2271, 2297, Appendix A, ¶ 2.1 (2002); *International Authorizations Granted*, IB Docket No. 04-4, Public Notice, DA 04-628, at 2-3 (rel. March 8, 2004) (granting the assignment and transfer of control of satellite licenses subject to assumption of agreements previously made with law enforcement agencies); *Motient Services Inc. and TMI Communications and Company, LP, Assignors and Mobile Satellite Ventures Subsidiary LLC, Assignee,* 16 FCC Rcd 20469, ¶¶ 31-34 (2001); *Lockheed Martin Global Telecommunications, Comsat Corporation, and Comsat General Corporation, Assignor and Telenor Satellite Mobile Service, Inc. and Telenor Satellite Inc., Assignee, Applications for Assignment of Section 214 Authorizations, Private Land Mobile Radio Licenses, Experimental Licenses, and Earth Station Licenses and Petition for Declaratory Ruling Pursuant to Section 310(b)(4) of the Communications Act*, File No. SES-ASG-20010504-00896, Order and Authorization, FCC 01-369, at Appendix B, 2.2 (2001) (requiring that all domestic communications be transmitted through U.S. earth stations or routed through a point of presence "that includes a network switch or router under the control of" the licensee in the United States).

Boeing has maintained an ongoing dialogue with the various concerned law enforcement agencies for a number of years in regard to the development of capabilities to support law enforcement's mission and public safety needs onboard aircraft. Boeing intends to continue to work with the Departments to reach appropriate understandings in regard to their legitimate law enforcement, public safety and national security requirements. In light of the existing CALEA framework, and the likelihood of system-by-system security agreements, the Commission should conclude that law enforcement needs are being addressed appropriately and that no further rules of general applicability are required before approving the use of wireless devices aboard aircraft.

CONCLUSION

For all of the foregoing reasons, the Commission should adopt rules and policies for airborne wireless services consistent with Boeing's comments in this proceeding and these reply comments.

Respectfully submitted,

THE BOEING COMPANY

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